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ABSTRACT

This discussion of the influence of robotics on the individual and society addresses three major topics: (1) the current employment picture and future expectations; (2) developments in the robotics industry and their impact on the changing character of work; and (3) the implications of these changes for both society and the individual worker. The impact of the information revolution on the workplace is reviewed, an employment picture for 12 occupations is projected for the year 2000, and additional changes that robotics and other technologies will bring to society are discussed. An overview is given of the impact of robotics on the types of jobs that will be available, the kind of training that workers will need, and the plight of the displaced worker, including predictions of the levels of automation in industry for the years 1985 to 1990. Summaries are provided of five major reports on the social impact of robotics from Carnegie-Mellon University (1981), the Joint Economic Committee (1982), the Office of Technology Assessment (1982), the Society of Manufacturing Engineers and the University of Michigan (1982), and the W. E. Upjohn Institute for Employment Research (1982) respectively. Concluding statements include six recommendations designed to help restore the competitiveness of U.S. industry in the work marketplace that were developed by the National Research Council and the Business-Higher Education Forum, and a brief discussion of ways in which the robotics industry can respond to social change. A 12-item bibliography is provided. (JB)

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HUMAN FACTORS BEYOND THE WORKPLACE:

A SOCIAL CONTEXT FOR ROBOTICS

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I

A Society in Transition

While the revolution from an agricultural to an industrial society took 100 years, the present restructuring from an industrial society to an information society has taken only 20. The rapidity with which this second revolution has occurred has made adaptation to the social changes taking place difficult. Indeed for the United States it appears that the economy has changed before its thinking has. The information revolution has had major influence on dramatic changes taking place in the work-force--the most obvious being the mounting number of displaced workers. Today, we are well aware the Information Revolution is occurring; we are in a post-industrial society; and blue-collar work (and some white collar work) is being replaced by knowledge technology.

An April, 1982 United States Census Bureau report confirmed the fact that the Nation has moved from a production-based economy to a service-based economy. A conclusion based on the fact that only 20% of U.S. workers are now involved with the manufacturing of products, while 65% are providing informational services. The most essential resources identified in this service-based economy is educated people.

The Employment Picture

In the summer of 1982, a U.S. Congressional Budget Office report stated that by 1985 (two years from now) automation would eliminate 200,000 auto production jobs. It would reduce the steel work force by 2 to 3% through 1990. By the year 2000, industrial robots could eliminate 7 million jobs. On the other hand, by the 1990s, millions of new jobs are expected to be available.[1]

NEW OCCUPATIONS FORECAST FOR THE 1990s

Occupation	Available Jobs
Industrial Laser Process Technicians	2,500,000
Battery Technicians	2,500,000
Housing Rehabilitation Technician	1,750,000
Industrial Robot Production Technicians	1,500,000
Energy Technician	1,500,000
Hazardous Waste Management Technician	1,500,000
Paramedic	1,300,000
Geriatric Social Worker	1,000,000
Materials Utilization Technician	500,000
Holographic Inspection Specialist	200,000
Bionic-Electronic Technician	200,000
Genetic Engineering Technician	150,000
Total Jobs Forecast	14,500,000

There is much promise if those occupations actually appear, especially in the numbers forecast. However, the nature of these occupations makes very evident this is not an unskilled or semi-skilled work force we are talking about. Interestingly, other indicators are already revealing a surplus of robot technicians.

As to the job outlook for this decade for factory workers, many traditional manufacturing jobs will be lost to automation; many younger workers without seniority will never be called back. In the 1980s, jobs programs will be needed for people with good employment records, but with the wrong skills. In the industrial heartland of the United States (Michigan, Ohio, Indiana, Illinois, Wisconsin) 970,000 more jobs will be lost.

For women the picture is brighter. In April, the U.S. Department of Labor reported that two thirds of newly hired workers were women--most employed in the service industries. Very likely the average woman will have a better chance of finding a job than the average man. Although many of those jobs will be at the lower end of the income scale.

For high school graduates things are also looking up. The skilled worker of the 1980s will work in an office or a laboratory, not in a factory. The myth that a high tech society needs more college graduates will be exposed. What will be needed are more technically trained workers. Therefore, high school graduates with good oral and written communication skills, along with basic training in computers, word processors, other new technologies increasingly will be essential members of the information society's workforce.

College graduates will find times more difficult. Already there are fewer job opportunities and starting salaries are lower. Those who are technically trained--engineers, computer scientists--will command the larger starting salaries. Technically trained high school graduates are likely to earn more than college graduates with non-technical training (humanities, teaching, etc.). However, it still pays to get a college education. College trained workers, thus far, do not suffer as high a jobless rate as other workers.

There also will be a significant reduction of middle management as automation permeates the workplace.

During this decade: (1) job choices are likely to be slimmer; (2) more people will be settling for different jobs than they expected; and (3) pay is likely to be lower.

Future Expectations

More about what the future might hold--by the year 2000 the factory assembly line will be a thing of the past. Japan will continue to have the largest robot population with over 11,000,000 by the turn of the century. In the United States, big business will grow even larger dominating the markets of the new technologies and services. General

Motors will make small, fuel-cell powered cars for local travel and buses for mass transit in congested urban areas. While General Motors will remain profitable for many years, by the year 2010 it could vanish from the leading ranks of corporate conglomerations.[2]

Population changes also will have a dramatic impact on the composition of our workforce. For example, we can expect a dramatic increase in the median age of Americans; a precipitous decline in the number of teenagers; and a dramatic increase in those over age 65. Further, the U.S. population, now 232 million, will expand by less than 1% to the year 2000 with growth possibly ceasing and peaking at 309 million by 2050. For the American workforce, these population changes will result in fewer young workers, more middle-aged workers, and a declining number of workers overall. In addition, these trends suggest that unemployment will subside as a persistent problem. We simply will not have available today's number of workers. Enrollments in secondary schools and colleges will decline. And productivity as a result of automation, and subsequently competition of U.S. businesses will escalate.

What else might we anticipate as a result of robotics and the other new technologies? We can anticipate the need for workers will dwindle as machines take over more and more of the work of humans. There will be a restructuring of the work week, which is likely to be shortened from five days to four to accommodate the reduced need for workers. Such a change has not occurred in almost a century. There also will be an adjustment in compensation for work. Hourly wage is likely to be eliminated and replaced by salaried compensation. High tech jobs can be expected to increase by 50% by the end of this decade. The government will take a much more active part in addressing the social impact of the high

technologies, which so far it has grossly underestimated. The manufacturing industries will become increasingly service oriented. The information/service economy will become even more highly skilled and filled with knowledge workers. The role of education in preparing the workers of the future and keeping the knowledge and skills of the current workforce up-to-date will expand dramatically.

II

The Robotics Industry: The State of the Art

Three major new growth industries are projected to develop over the next 20 years. They are (1) telecommunications, (2) biotechnology, and (3) robotics. The focus here is on the evolution of the robotics industry in the United States. One dimension of the robotics industry, frequently overlooked, relates to its projected impact on the United States and worldwide. The developing diversification of the industry provides explanation for its classification as one of the three major growth industries. Industrial robots, dominating the scene these days, represent only one dimension of the growing robot industry. Expansion of the industry also includes the following categories of robot development already underway: nuclear robots, medical robots, mining robots, genetic robots, underwater robots, space robots, entertainment robots, education robots, and household robots. These are the things to come. Already several household robots are on the market for us consumers to take advantage of. We can buy them assembled or in kits to put together. This was not suppose to happen for twenty years. We need to question the predictions we are hearing--technology seems to be advancing at a much more rapid rate than we are able to anticipate. Indeed, robots will contribute significantly to altering our present way of life.

Impact on Work

What impact will robotics have on the changing character of work? The Society of Manufacturing Engineers predicts:

- by 1985--20% of the labor force employed in the final assembly of automobiles will be replaced by automation;
- by 1985--vision systems will provide enough feedback for robots to select parts scrambled in a bin;

.by 1987--15% of all assembly systems will use robot technology;

.by 1988--50% of the labor in small component assembly will be replaced by automation;

.by 1990--the development of sensory techniques will enable robots to approximate human capability in assembly.

Initially, robots were thought of as replacements to do undesirable, hazardous jobs, but increasingly they are moving into more desirable, skilled occupations. New technology is making it possible to replace more highly skilled workers. If such a trend continues it may result in the further stratification of workers into two basic groups: (1) those with managerial and highly skilled training; and (2) those at entry level, who are unskilled and semi-skilled. This trend will have dramatic impact on our social strata. The top band of the social strata will consist of the growing number of knowledge workers, while the lower band will consist of a growing number of workers unable to qualify. The middle band, our middle class, will become increasingly amorphous, and access to the top band increasingly difficult.

Over half of all unskilled and semi-skilled workers in jobs that could be replaced by robots are in the five major metal working industries (primary metals; fabricated metals; machinery, except electrical and electronic equipment; and transportation*) and half of the production workers in those industries are located in the industrial Midwest of the United States. The picture is further complicated by the fact that a vast majority of manufacturing workers still have 20 or more years of active work life left. As of 1980, between two-thirds and three-fourths of these workers were under age 45, which means that barely a third of that workforce will have retired by the year 2000.[3]

*classifications according to those in the Occupational Handbook, U.S. Department of Labor.

The big winners in the rush to robotize factories in the United States will be the Nation's women. The rise of robots means that factory jobs no longer require muscular strength and the ability to tolerate noise and dirt on the job. It is predicted that by the year 1990 women will comprise over one-half of the factory work force.

III

Social Implications of Robotics

As to the influence of robotics on the individual and society, we can look at the social context through four areas of individual human interaction--family life, learning life, work life, and leisure life. The focus of this discussion is on the transition from an industrial society to an information society, and on the changing nature of work life as a result of robotics and the other high technologies.

Societal Changes

In 1973 at the First Conference on Industrial Robot Technology, a paper was presented on the impact of robots on everyday life, still relevant today.[4] Discussed was the establishment of a creative society, basing individual success not on amount of payment and acquired goods, but rather on self-fulfillment through creative achievements. It was hypothesized that the prolific use of robots would contribute to this happening because they eliminate boring repetitive jobs; eliminate dangerous and uncomfortable work; and reduce the need for long hours of work by humans.

Thring of the U.K. (the author), foresaw robots built able to learn to use tools with exact skills, to coordinate sight and touch sensations--our second generation robots now being developed. He also noted that a robot will never be able to do more ordered and sophisticated tasks than a human has instructed it to do. Even though it will become possible to build a computer as compact, with as many storage units and interconnections as the human brain, and with artificial intelligence commensurate to the intellectual brain of a person, a robot will never be built with an emotional brain dealing with feelings and

attitudes. Nor will one be built that is able to produce its own original creation or invention.

Russian born economist and Nobel laureate Wassily Leontif places the silicon chip and its progeny, integrated circuits and computers, among humankind's great technological achievements--alongside James Watt's 1765 invention of the steam engine, the catalyst of the industrial revolution. According to Professor Leontif:

> The role of Humans as ordinary intelligent creatures will diminish as scientists and engineers continue to work, they will develop automatic devices that will replace higher and higher mental capabilities. In time, the work week, the work day, the work life will shrink enormously. Competition from computers and robots will put immense downward pressure on wages, requiring that the government develop new ways to distribute income much as it does now through social security.[5]

High unemployment of unskilled and semi-skilled workers is inevitable as the use of robots expands. This is further aggravated by the concurrently changing economy from one of perpetual expansion to one of equilibrium. The evolving equilibrium economy is characterized by shortened work hours, redistribution of work assignments, and great expansion of services. The demand for individuals to learn and use new information and skills is now perpetual.

Impact on the Worker

Just this year, 1983, Robert Ayres and Steven Miller of Carnegie-Mellon University published Robotics, Applications and Social Implications examining the evolution and use of robot technology, and its consequence for employment, productivity, and public policy. The social costs of robotization are addressed through four significant questions which focus on its impact on employment.

1. Would more widespread use of robots create a special employment problem--as contrasted with problems associated with automation generally--and for whom would it be a problem?

2. What are the estimates of the potential displacement likely to be created by robots over the next two decades and how reliable are the estimates?

3. Would more general use of robots have regional consequences for employment more far-reaching than its impact on the overall economy?

4. Are existing collective bargaining and labor market arrangements likely to provide remedies for the displacement created by robots while minimizing the barriers to their use?[6]

To get a handle on the information available addressing worker populations and robotics, this researcher conducted an extensive literature review of over 500 abstracts retrieved from several data bases. The major descriptors used to identify sources were robotics to human factors or education to five worker populations--youth, women, minorities, older workers, and displaced workers. Of the approximately 500 identified 94 articles in some way touched upon the social implications of robotics, the majority focusing on worker adaptation to robots in the workplace. Many concentrated on the training and retraining of those workers who would interact with robots. A few discussed the impact of robots on our society and on the individual worker, especially relating to the issue of job displacement. Of the five special worker groups, the following number of articles was identified: On youth--one; on women--two; on minorities--one; on older workers--none; on displaced wokers--sixteen. Much work needs to be done...

Special Reports. A number of major reports addressing the social impacts of robotics, even if only peripherally, have come out within the past eighteen months. To review briefly:

1. The Carnegie-Mellon report, The Impact of Robotics on the Workforce and Workplace, came out in mid-1981.[7] It is based on a fifteen-week project conducted by students. The report pays special attention to preparation of the workforce most likely to be affected by the inevitable changes occurring with the introduction of robots. These recommendations are offered: (1) long range planning by industry for future employment requirements by job skill and location; (2) identification of vulnerable categories of workers well in advance of actual job elimination; and (3) provision of effective retraining facilities to upgrade workers from skill categories that are in surplus supply to skill categories that are scarce.

2. The Joint Economic Committee report, Robotics and the Economy, which came out in early 1982 presents the interpretations of an economist on the Committee staff.[8] The essay discusses the structural changes in employment that will occur due to the installation of robots, and the commensurate essential need for training and retraining workers. Also, it is anticipated that labor's involvement in retraining will escalate as a result.

3. The Office of Technology Assessment (OTA) report, Exploratory Workshop on the Social Impacts of Robotics came out about the same time as the Joint Economic Committee report.[9] It is the only one to specifically address the social implications of robotics and focuses on five sets of issues: (1) productivity and capital formation, (2) labor, (3) education and training, (4) international impacts, and (5) other applications (military, space, oceans, etc.). It is based on a workshop conducted by OTA involving representatives from business, industry, labor, government and higher education.

4. The Society of Manufacturing Engineers and University of Michigan study report, Industrial Robots, A Delphi Forecast of Markets and Technology, completed in 1982, focuses on projections to the year 1995.[10] The study entails the inputs of a panel of 60 experts in robotics, the majority coming from robot using firms. The forecasts are based on the results of three questionnaires addressing (1) design and application of robots, (2) U.S. markets for robots, and (3) the sociological impact of robots on the worker and in the workplace.

5. To provide clarification on the impact of robotics on human resources in Michigan, the W. E. Upjohn Institute for Employment Research conducted the most recent study, Human Resource Implications of Robotics. The report tells us that by the end of 1982, approximately 6800 to 7000 robots were operating in U.S. factories. Employment in U.S. robot manufacturing is roughly 2000 workers nationwide today. By the year 1990, the total industrial robot population in the U.S. will be somewhere between 50,000 and 100,000 units. The most remarkable impact of robotics is what the study calls the skill-twist that emerges when the jobs eliminated are compared to the jobs created. The jobs eliminated are semi-skilled or unskilled, while the jobs created require significant technical background. In terms of the number of workers displaced by industrial robots, as well as the jobs created, it appears rather insignificant when compared to the total number of unemployed workers. The report says job displacement due to robots will not be a general problem before 1990.

All five reports acknowledge the changing structure of employment and the nature of work. All acknowledge the inevitability of substantial numbers of displaced workers. All highlight the disparity which

exists between the occupational demands of the robotics industry and the inadequacy of existing training/education efforts. Although alluded to, none discuss the diversification of the robotics industry beyond industrial robots. None discuss the transferrability of skills germane to robotics that are applicable to other emerging occupations as well. All refer to social implications in terms of employment impacts.

Adapting to Change

About today's displaced workers, we may have a lost generation. As the impact of technology becomes more pronounced, those most likely to suffer in the future are those about to enter the workforce, expecting employment in the traditional unskilled/semi-skilled jobs that are rapidly disappearing. Factory and manufacturing jobs that are being outmoded by the robotics industry include: machinists (lathe, milling, grinding, stamping); finishing (deburring, spraying, polishing); inventory (warehousemen, inventory clerical); fitters, riveters, cutters, machine loaders and parts handlers; and packers.

We have not yet discovered the means for solving the employment dilemma we are faced with in this transition from an industrial-product based society to an information-service based society. The change from an economy of perpetual expansion, which we all grew up under, to one of equilibrium, no growth or slow growth, will probably remain the pattern. Where the world of work is concerned, "downsizing by design" might well be today's theme, reluctant as we are to admit it. Saving obsolete jobs is clearly not the answer. Neither is government support of obsolete industries.

Where are the Nation's business and education leaders in all of this? Two high level study groups of corporate and university chief

executives have come out urging federal government help in restoring the competitiveness of United States industry in the world market place.[12] Both the National Research Council and the Business-Higher Education Forum (established by President Reagan) argue that the United States can meet foreign competition by relying on its base of research universities; strong industrial technology; abundant venture capital; and a unique entrepreneurial climate. They urge the establishment of a cohesive National industrial policy. Major recommendations from both groups include: (1) the elimination of overlapping regulations; (2) tax incentives for investment in research and development; (3) increased government support for research and development; (4) the new policy of granting all contractors title to inventions developed with government funds be written into law; (5) revision of antitrust laws to allow joint research on industry-wide problems to be conducted by large and small companies; and (6) the coordination of conflicting foreign trade policies and aggressive negotiation against foreign trade barriers. Profit and productivity was the focus of both study groups. The third "p", people, appears to have been overlooked. Human capital investment, our most valuable resource, was not a consideration.

How can the robotics industry respond to these social changes? As one of the leaders in this wave of social change, for the robotics industry human capital investment is the key. That investment entails lifelong learning, entrepreneurship, a risk-taking climate, and innovation and invention. It also contributes to changes in social values, especially the redifinition of the work ethic. Primary considerations include: (1) redistribution of income, (2) the reduction of work week, and (3) the elimination of waged labor. The restructuring

of work life is inevitable and will contribute dramatically to the reinterpretation of quality of life for the individual.

References

[1]Cetron, Marvin and Thomas O'Toole. "Careers With a Future: Where the Jobs Will Be in the 1990s," The Futurist (June, 1982), 11-19.

[2]Weil, Robert, ed. The Omni Future Almanac. Chapter 5. New York: Harmony Books, 1982.

[3]Ayres, Robert and Steve Miller. "Industrial Robots on the Line," Technology Review (May/June, 1982) 35-46.

[4]Thring, M. W. "The Impact of Robots in Everyday Life," Proceedings of the First Conference in Industrial Robot Technology. University of Nottingham, United Kingdom (March 27-29, 1972) pp. R19-217 - R19-222.

[5]Kilborn, Peter T. "The Twilight of Smokestack America," New York Times (May 8, 1983), pp. 3.1 & 3.29.

[6]Ayres, Robert U. and Steven M. Miller. Robotics Applications and Social Implications. Cambridge, Mass.: Bollinger, 1983.

[7]The Impacts of Robotics on the Workforce and Workplace. Pittsburgh, Pa.: Department of Engineering and Public Policy, Carnegie-Mellon University, 1981.

[8]Vedder, Richard K. Robotics and the Economy. Washington, D.C.: U.S. Government Printing Office, March, 1982.

[9]Office of Technology Assessment. Exploratory Workshop on the Social Impacts of Robotics. Washington, D.C.: U.S. Congress, February, 1982.

[10]Smith, Donald N. and Richard C. Wilson. Industrial Robots: A Delphi Forecast of Markets and Technology. Dearborn, Mich.: Society of Manufacturing Engineers/University of Michigan, 1982.

[11]Hunt, H. Allan and Timothy L. Hunt. Human Resource Implications of Robotics. Kalamazoo, Mich.: W. B. Upjohn Institute, 1983.

[12]"An Industry Plea for the Freedom to Compete," Business Week, (June 6, 1983) pp. 59 & 60.